The RDXF Response to a Monetary Shock Using Alternative Short-Run Slopes for the Phillips Curve

by J.-P. Aubry and K. Acheson

The Research Department of the Bank of Canada undertook the preparation of the study "Price Flexibility and Business Cycle Fluctuations in Canada - A Survey" for the Royal Commission on the Economic Union and Development Prospects for Canada. This paper was a working document for the study. The views expressed are those of the author(s): no responsibility for them should be attributed to the Bank of Canada.

The authors would like to thank colleagues at the Bank for their contributions and comments. However, the authors take full responsibility for the content of the paper.

THE RDXF RESPONSE TO A MONETARY SHOCK USING ALTERNATIVE SHORT-RUN SLOPES FOR THE PHILLIPS CURVE

Many economists suggest that the slow adjustment of prices from one equilibrium value to another is one source of the fluctuations of real output. One way of testing this assertion is to see if output fluctuations are smaller in an environment where prices are less sticky. These tests should involve analysis of the output response to a large number of shocks which have generated past economic cycles. In this note, however, we have restricted ourselves to the analysis of the output cycle produced by only one type of shock, an unexpected money supply increase. We have simulated this shock in the RDXF model[1] and we have looked at how sensitive the cyclical response is to modifications to the wage equation, an expectations-augmented Phillips curve.

This note is divided in three sections. In the first section we briefly explain the RDXF dynamics in the response to a money supply shock. In the second section, we describe the model response to a money level shock and to a money growth rate shock, with alternative specifications of the Phillips curve, namely, a change in the short-run slope and a change that links nominal wage formation directly to money growth. Finally, in the conclusion we discuss the RDXF response to other types of shocks.

I RDXF Dynamics

For the purpose of this note, we explain the RDXF dynamics[2] in the Phillips curve framework. An increase in the money supply generates in the short run an increase in economic activity (the standard IS curve) via the reduction in nominal and real interest rates. The short-term increase in activity implies a reduction in the unemployment rate which in turn puts upward pressure on wages. The channel by which prices can be directly influenced by the supply-demand imbalance term is extremely weak in RDXF. With the increase in labour costs, prices and the exchange rate,

1. The September 1983 Version of RDXF was used for the simulations. It was modified by allowing Canadian energy prices to be tied directly to world prices and by removing the effects of interest rates from the equations for house prices and for the deflator for rent. The October 1983 medium-term base case was used as a control solution.

The simulations were performed over the period 1983Q3 to 1988Q4. In implementing the shocks, the money supply was adjusted to its new long-run level (in the case of the level shock) or rate of growth (for the growth rate shock) over a period of four quarters.

2. For more details see Robertson and McDougall (1982).

This paper is one of the series of working papers for "Price Flexibility and Business Cycle Fluctuations in Canada - A Survey", a study prepared by the Research Department of the Bank of Canada for the Royal Commission on the Economic Union and Development Prospects for Canada. These research papers were all completed in early 1984.

which is mainly determined by purchasing power parity, PPP, start to move up. In RDXF the sectors where the activity is increasing the most are the housing sector, the investment sector and the trade sector. One should note that net exports of goods increase because a depreciation in excess of the PPP effect is generated by the interest rate reduction. It is interesting to note that consumption falls despite an increase in real wages. This is caused by the reduction in interest and (non-dividend) investment income and by the reduction in real transfers which more than offset the effects of higher labour income on the purchasing power of consumers.

In RDXF, inflationary expectations are not directly linked to the observed or the expected money supply behaviour; the main channel by which the money shock is transmitted to prices is the Phillips curve

$$\dot{W} = PR\dot{O}D + \lambda\ (RNU-RNUTO) + \gamma\ (L)\dot{P}_{-1}$$

where $\dot{W}$ = the growth of the nominal wage rate,

$PR\dot{O}D$ = the growth of labour productivity,

$\gamma\ (L)\dot{P}_{-1}$ = expected inflation based on past inflation experience,

(RNU-RNUTO) = the labour market gap defined as the difference between the unemployment rate and the unemployment rate at trend output, and

λ = the short-run slope of the Phillips curve.

In that context the price response to a monetary shock is a function of the amplitude of the economic cycle generated by the reduction in interest rates and by the short-run slope of the Phillips curve (λ).

In an accelerationist model, prices move until the gap (RNU-RNUTO) is closed. This happens when prices have fully adjusted to the money shock and when interest rates return to equilibrium. For our simulations we used an RDXF control over the 1984-88 period. We did two basic shocks, a 1% increase in the money supply and a 1 percentage point increase in the money supply growth rate. For each of these shocks, two different versions of RDXF were used, the current version and the current version modified by the doubling of the short-run slope (λ) of the Phillips curve. This is a way of simulating a reduction in price stickiness. As well, a third version of RDXF was used for the money growth shock; in this version, adaptive expectations on inflation, only in the wage equation, are replaced by a rapid wage adjustment, RWA, where inflation expectations

are linked directly to growth of money supply.[3]

II RDXF Simulation Results

A one per cent increase in the money supply

After five years, a permanent 1% increase in the money supply (M1) generates in RDXF a 0.50% increase in the GNE deflator and a 0.68% depreciation of the Canadian dollar. This price response is generated by a short-run increase in output which peaks at a level of 0.2% above its control solution in 1984 and which represents, if we make the integration, a 0.52% gain in real output over the entire period. The reader should note that, because of the incomplete adjustment of the price level to the money supply shock, real money balances are above their control levels throughout the simulation period and consequently, nominal interest rates must lie below their control values in order to equilibrate the money market. This explains why the exchange rate, which adjusts only gradually to changes in the domestic price level (through the PPP term), in fact shows a stronger response than either the GNE deflator or the CPI[4]. The unemployment response (a total of -0.25 points after five years) follows more or less the output response.

If the short-run slope of the Phillips curve is doubled, the RDXF price response is increased by an additional 22% in 1988 reaching a level that is 0.61% above its control solution. The integral of the output response is reduced by the same amount. The difference between the two simulation responses is even larger for the unemployment rate variable. In this second simulation the real wage increases by 0.14% compared with a 0.1% increase in the first simulation. It is interesting to notice that, despite the larger demand implied by the relative increase in real wage, the overall output response is smaller because of dominating supply effects. These effects are coming mainly via two channels. With a faster price response the real exchange rate depreciation is less and net trade has a smaller effect. The real wage marginal gain is offset by a reduction in employment (substitution effect) and by a larger reduction in the real component of the other types of income.

A one percentage point increase in the money supply growth

As shown in Chart 2 the same type of relative pattern occurs in the money growth shock. In the estimated version of RDXF, price inflation is increased by 0.5 percentage points by 1988 while the Canadian dollar is

---

3. The expected rate of inflation in this simulation is given by an 8-period moving average of the growth in M1. The slow adjustment of the expected inflation rate to the changed money supply growth captures the lags of actual inflation in responding to the shock.

4. The exchange rate is not only a function of PPP but also of the interest rate differential between U.S. and Canadian short-term interest rates.

depreciating at a rate of 0.6% per annum. The output response seems to reach a peak (0.51% in 1987) and the unemployment rate to start to return to its control solution by 1988. With the RDXF version using a steeper short-run Phillips curve, the price response is larger and the output and the unemployment rate response is smaller. This reduction is, however, proportionally smaller than in the money level shock.

The money growth shock was also applied to a version of RDXF in which we constrained nominal wages to react directly (but gradually), one to one, to the monetary aggregates. This can be interpreted as linking expectations in wage determination directly to money or reducing labour market rigidities. As shown in Chart 2, this version of RDXF follows much more closely the "monetarist theory". By 1988 price inflation is increased by 0.9 percentage points and the output fluctuations are much smaller than in the estimated version. By 1988 output is going back to its control solution. In this simulation, however, the real wage and the unemployment rate are moving further away from their control solution. We should not be surprised by this response, given the asymmetry of the response to the monetary shock. If one market is reacting much more quickly to a shock than other markets we will see some distortions. If we had also decided to apply money-derived expectations in the price and exchange rate sectors, the real wage and the unemployment rate would have remained much closer to their control solutions.

III Conclusion

The simple simulations presented in the previous section support the view that real output fluctuations can be reduced, when the economy faces a permanent money supply shock, if wages react more quickly to labour market disequilibrium or if expectations are generated more "rationally". It is clear from our simulations that distortions can be created if we allow one market to react much faster than other markets. In large models where we have more than one quantity and one price the flexibility of the response of these prices to different real or nominal shocks should be analyzed globally. From the simulations described in this paper we can see that the real sector would be less affected by a monetary shock if all prices were to react more quickly to the supply-demand imbalance.

This conclusion can be extended to a real shock (i.e., a government spending shock) in an environment of non-accommodating monetary policy. With a steeper Phillips curve, the initial real output increase will be transmitted more quickly into rising prices. By using a simulation rule that prevents money from diverging from the control solution, interest rates will rise and the ultimate outcome will be a reduction in the multiplier-accelerator mechanism.

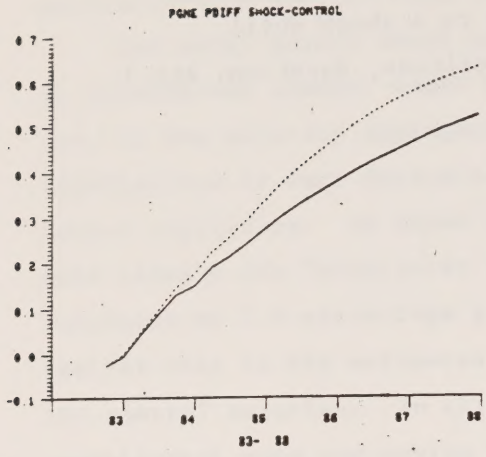
In a world where there are a multitude of shocks and especially where uncertainty is an important component of the decision process it is much more difficult to assert that output fluctuations can be reduced if one

shifts to an environment with less sticky prices. For example, if economic agents interpret a shock incorrectly, they can change their expectations away from the true economic equilibrium and these expectations may generate important real fluctuations that can last until they correctly revise their expectations. In this vein, we can imagine all sorts of shocks that can be applied to a macro model like RDXF. Sometimes it might be better to react slowly to a shock until uncertainties on the nature of the shock (amplitude, duration, etc.) disappear.

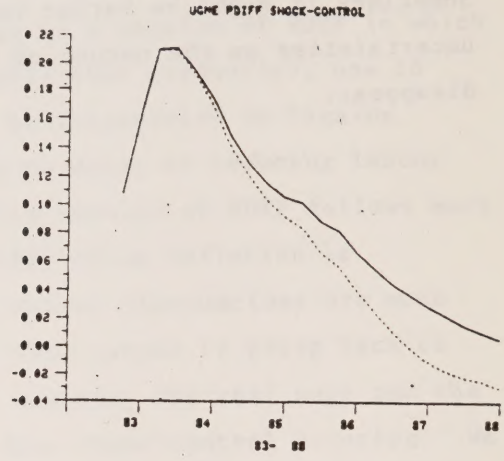
CHART 1

RDXF Response to 1% Increase in Money Supply
(shock-control, level *, % **)

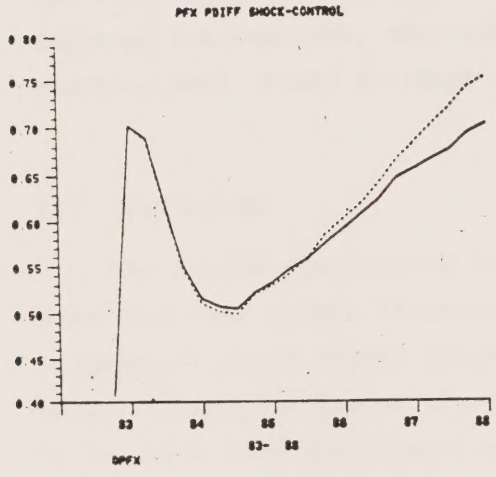
GNE DEFLATOR **



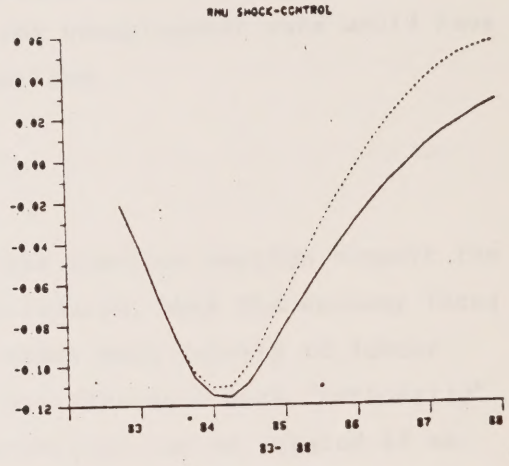
GNE **



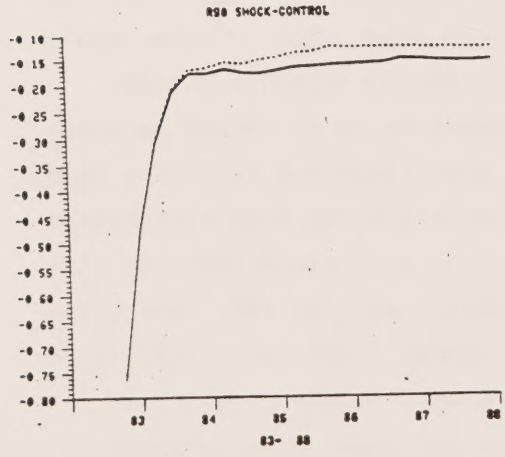
EXCHANGE RATE **



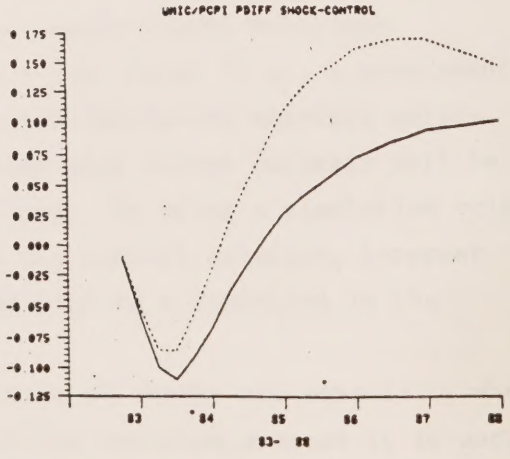
UNEMPLOYMENT RATE *



SHORT TERM INTEREST RATE *



REAL WAGE **

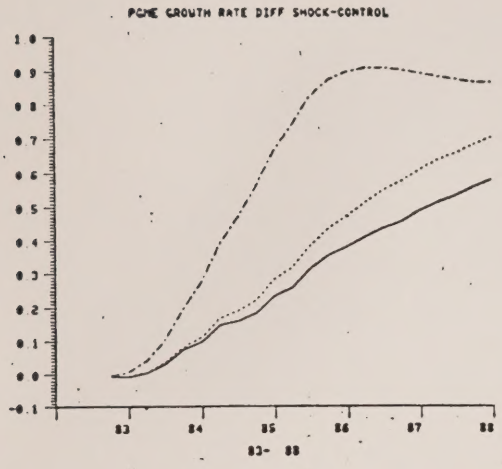


——— RDXF
------- RDXF with the steeper Phillips curve

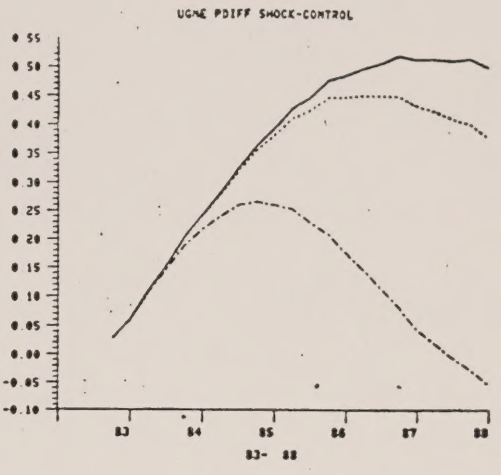
CHART 2

RDXF Response to a 1 Percentage Point
Increase in the Rate of Growth of the Money Supply
(shock-control, level *, % **, growth rate ***)

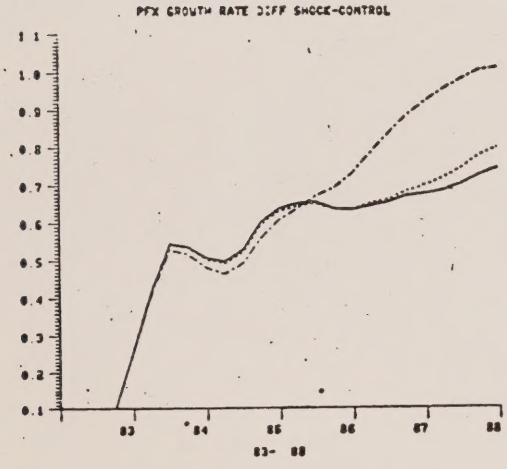
GNE DEFLATOR ***



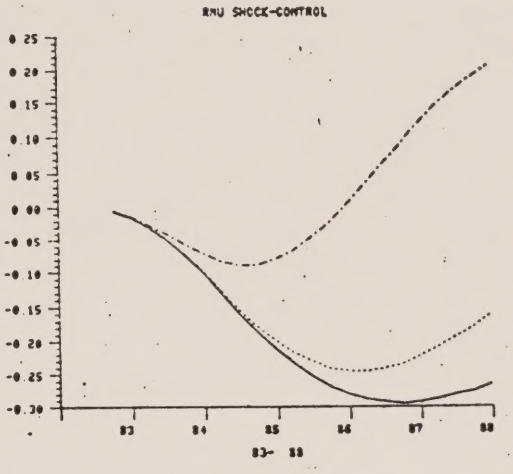
GNE **



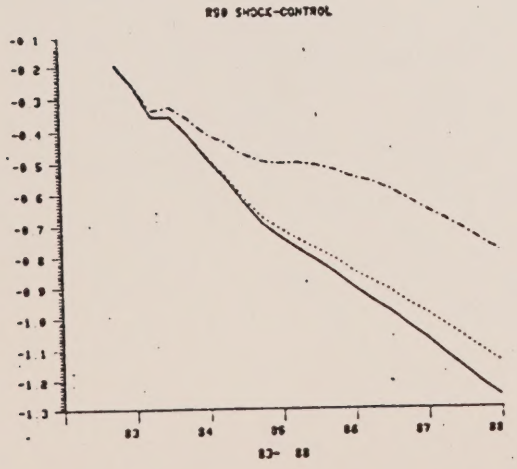
EXCHANGE RATE ***



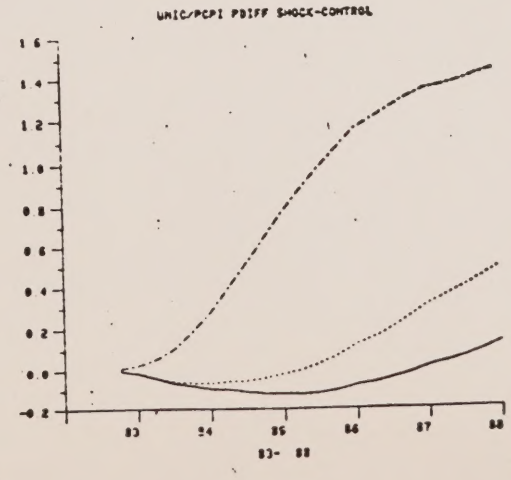
UNEMPLOYMENT RATE *



SHORT TERM INTEREST RATE *



REAL WAGE **



——— RDXF
------ RDXF with the steeper Phillips curve
— — — RDXF with nominal wage growth directly linked to money growth

REFERENCES

Robertson, H., McDougall, M. (1982). The Structure and the Dynamics of RDXF, Technical Report 26, Bank of Canada.

Seminar on Responses of Various Models to Selected Policy Shocks, Ottawa, 1982, sponsored by the Bank of Canada and the Department of Finance.